REMARKS

Reconsideration of the application in view of the above amendments and following remarks is respectfully requested. In the above amendment, claims 1, 3-7 and 17-24 are currently being amended, claim 8 is currently being canceled without prejudice, and claims 25-33 are currently being added. Therefore, claims 1-7 and 9-33 are pending in the application.

Information Disclosure Statement (IDS)

A Supplemental IDS is being filed herewith. Applicant requests that the Examiner consider the references cited therein and provide Applicant with an initialed copy of the PTO-1499 Form indicating that the references were considered.

Objections to the Drawings

Applicant has enclosed herewith a Replacement Sheet for FIG. 21, which is believed to satisfy the objections to the drawings. The changes made to FIG. 21 are that the reference characters 1, 2, and 3 have been changed to PC 1, PC 2, and PC 3. As such, the objections should be withdrawn.

Objections to the Specification

Applicant has amended the Title of the Invention in accordance with the Examiner's suggestion. As such, the objection to the title should be withdrawn.

Support for Claim Amendments

Independent claim 1 has been amended to recite that the grouping unit selects rendering strategy according to

characteristics of input three-dimensional objects and groups the three-dimensional objects into groups in such a manner that the three-dimensional objects to which the same rendering strategy is applied are grouped into the same group, and that the rendering processing is performed individually on the subspace by applying the group by group different rendering strategy. These additional features are supported by, for example, page 59, lines 9-13 of the specification. The same applies for amended independent Claims 17, 18, 20, and 21.

The amendments to Claims 3 and 4 are supported by, for example, page 60, lines 2-22 of the specification.

The amendments to Claims 5 and 6 are supported by, for example, page 37, lines 1-6 of the specification.

The amendments to Claim 19 are supported by, for example, page 40, line 11 - page 41, line 21 of the specification.

New Claim 25 is supported by, for example, page 36, lines 11-13 and page 37, lines 11-19 of the specification.

New Claim 26 is supported by, for example, page 71, lines 14-19 and page 37, lines 13-14 of the specification.

New Claim 27 is supported by, for example, page 37, lines 16-19 of the specification.

New Claims 28 and 29 are supported by, for example, page 37, lines 6-10 of the specification.

New Claim 30 is supported by, for example, page 47, lines 6-13 and page 33, line 13 - page 34, line 18 of the specification.

New Claim 31 is supported by, for example, page 56 with the example of the airplane 230 and the mountains 234.

New Claims 32 and 33 is supported by, for example, page 22, line 16 - page 23, line 7, together with FIGS. 5A-5E.

Claim Rejections under 35 U.S.C. § 101

Claims 21-24 have been rejected under 35 U.S.C. 101 as allegedly being directed to non-statutory subject matter. Applicant respectfully traverses these rejections.

Applicant has amended claims 21-24 to recite a "storage medium storing" a computer program, which is believed to be statutory subject matter. As such, the rejection should be withdrawn.

Claim Rejections under 35 U.S.C. § 102

Claims 1-8, 19, 20, 21 and 22 have been rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,999,189 to Kajiya et al. ("Kajiya et al."). Applicant respectfully traverses these rejections.

(1)Technical background and the problem to be solved:

Applicant believes that the present invention and the system disclosed in Kajiya et al. do not share the technical background and the problem to be solved. First, Applicant believes that it would be helpful to the Examiner to discuss the technical background of the system disclosed in Kajiya et al.

For a better understanding of the system disclosed in Kajiya et al, it is beneficial to know that the system disclosed in Kajiya et al. is based on a 3D graphics architecture, called "Talisman", which was presented at ACM SIGGRAPH in 1996. The following SIGGRAPH paper [1] is listed as one of the references in Kajiya et al.

[1] Jay Torborg and James T. Kajiya, "Talisman: Commodity Realtime 3D Graphics for the PC", ACM SIGGRAPH, Conference Proceedings, pp. 353-363, Aug. 4-9, 1996.

The following paper [2] also helps to understand the

technical background at the time when the Talisman architecture was developed.

[2] Anthony C. Barkans, "High quality rendering using the Talisman architecture", Proceedings of the ACM SIGGRAPH/EUROGRAPHICS workshop on Graphics hardware, pp. 79-88, Los Angeles, California, United States, August, 1997.

Both of the papers [1] and [2] are cited in the Supplemental IDS that accompanies this amendment.

With reference to the paper [2], the fundamental issue the Talisman Architecture attempted to solve is the memory bandwidth. Talisman addresses the bandwidth issue with three techniques:

(i) Capture bandwidth on chip where it is affordable;

(ii) Selective rendering; and

(iii) Aggressive use of compression.

(i) Capture bandwidth on chip:

In the Talisman architecture, each image is chunked into smaller pieces prior to rendering. Each chunk is 32 x 32 pixels. The chunking allows on-chip color buffers, on-chip Z-buffers, and an on-chip anti-aliasing engine. Having these units on-chip makes it possible to replace the external bandwidth requirements with on chip data accesses where the bandwidth is more affordable.

The on-chip data access architecture was developed to solve the DRAM bandwidth problem. Since the price of DRAM bandwidth was high in those days, the design that relies on bandwidth to external memory for performance was not cost-effective. Therefore, Talisman adopted the design based on exploiting on-chip bandwidth.

To exploit on-chip bandwidth, each image is divided into

chunks (it is also often referred to as "tiles") so that the on-chip memory can buffer each chunk data for benefiting from the faster on-chip data access.

(ii) Selective rendering:

In a game, the characters may move around, but the background remains nearly the same between two frames. In the Talisman architecture, in order to use selective rendering a scene is broken into objects. Each object is then rendered as its own DirectDraw surface (called a sprite when stored in the graphics hardware system memory). Each surface would typically contain objects that are spatially separated from other objects in the scene. For example: an airplane may be rendered to one surface and a mountain into another surface.

In Talisman, each surface (sprite) contains an object that does not penetrate another object. These surfaces could be as complex as an entire frame or a single object within the frame.

(iii) Aggressive use of compression:

Data transfers between chips require bandwidth. Compressed data requires less inter-chip bandwidth. In Talisman, most inter-chip data is passed in a compressed format, resulting in reduction in both bandwidth and storage requirements.

As described above, the Talisman architecture aims to solve the DRAM bandwidth problem and employs the "chunking" (or tiling) technology. The chunking or tiling technology employed in Talisman was passed to the other graphics systems such as the PowerVR series architecture. The following paragraphs in the Description of the Related Art section of the specification of the present application describes the technical background where

such a tiling architecture has been developed.

> "In order to achieve higher speed rendering processing, there is a division processing method, in which a region to be rendered is divided into small tile regions and rendering is done in parallel per tile. With this method, called tile rendering, it is possible to do the majority of processing on the on-chip memory so the degree of dependence on external memory used as frame buffer is minimal. As a result, compared to existing graphic chips using 3-D pipeline, memory bandwidth can be narrower." (Applicant's Specification, page 2, lines 5-13).

> "Since tile rendering differs greatly from the 3-D pipeline processing method, there is a compatibility problem with applications, and when the number of objects increases its efficiency is reduced because of sort processing." (Applicant's Specification, page 2, lines 19-22).

On the other hand, embodiments of the present invention aim to provide an image processing technology capable of flexibly handling diversified rendering strategies, each of which reflects characteristics of each object, and to achieve higher efficiency through parallel processing.

The general purpose of embodiments of the present invention is not to solve the memory bandwidth problem. Since the speed of the DRAM interface has increased and the cost of DRAM has now dropped, the design that relies on the external memory bandwidth is not overly costly any longer. Therefore, embodiments of the present invention do not employ any chunking or tiling technology. Embodiments of the present invention utilize the

division processing method, however. The purpose of employing the division processing method is not to solve the bandwidth problem, but to provide an individual flexible and optimal rendering strategy for each object.

(2) The comparison between Applicant's claims and the cited references:

According to Applicant's amended independent Claim 1, a grouping unit selects a rendering strategy according to characteristics of input three-dimensional objects and groups the three-dimensional objects into groups in such a manner that the three-dimensional objects to which the same rendering strategy is applied are grouped into the same group. A rendering processing unit derives a subspace which contains the three-dimensional objects belonging to the same group to be an independent rendering unit and performs rendering processing individually on the subspace by applying the group by group different rendering strategy, and generates independent image data for each subspace.

Thus, according to amended claim 1, the objects to which the same rendering strategy is applied are grouped into the same group and a subspace which contains the objects belonging to the same group is rendered applying the group by group different rendering strategy. Here, it should be noted that the objects belonging to the same group can be divided into a plurality of subspaces and the plurality of subspaces of the same group are rendered applying the same rendering strategy of the group.

In the system disclosed in Kajiya et al., the objects in a scene are assigned to image layers called gsprites. The system will generally use an independent gsprite for each non-interpenetrating object in the scene. (Kajiya et al., column 5,

lines 60-65). Kajiya et al. gives an example where the background objects and the other moving objects are separately assigned to the different gsprites. However, Kajiya et al. does not disclose nor suggest that the objects to be rendered are grouped into the separate groups depending on the difference in the rendering strategy, as in Applicant's amended claim 1.

Therefore, the significant technical features recited in Applicant's amended Claim 1 are neither disclosed nor suggested in Kajiya et al. As such, the rejections of Applicant's amended Claim 1 should be withdrawn, and the rejections of Applicant's amended independent Claims 20 and 21 should be withdrawn for similar reasons. The rejections of dependent Claims 2-7 and 22 should also be withdrawn for at least these same reasons.

Some of Applicant's dependent claims provide further details regarding the rendering strategy. Namely, the rendering strategy selected according to characteristics of the objects may be, for example, a rendering algorithm such as a hidden surface removal algorithm or a sharing algorithm. The rendering strategy may be motion blurring processing selected based on motion characteristics of the objects. The rendering strategy may be multi-resolution rendering or defocus processing selected based on information related to level of detail in rendering the objects. These particular rendering strategies are recited in amended claims 3-6 and new claims 25-29. Applicant asserts that Kajiya et al. does not disclose these particular rendering strategies, which provides additional reasons why the rejections of amended claims 3-6 should be withdrawn.

Applicant's amended independent Claim 19 recites dividing a space into subspaces which overlap one another and performing rendering processing independently by subspace unit on a three-

dimensional object in each of the subspaces "to generate rendering data having depth information on a pixel by pixel basis". Furthermore, amended independent Claim 19 recites consolidating the rendering data of the three-dimensional object in each of the subspaces by evaluating a distance in depth direction "on a pixel by pixel basis".

According to the system of Kajiya et al., the objects are assigned to the gsprites and each gsprite is divided into the image regions or chunks, and the object geometry for the object or object pieces assigned to a gsprite is sorted among these image regions or chunks. Next, object geometry for a chunk is rendered completely, and the resulting pixel data is compressed. (Kajiya et al., column 3, lines 30-33 and lines 43-47). Kajiya et al. also address that the image preprocessor determines the depth order of gsprites. The image preprocessor sorts objects in Z-order. In addition to sorting objects, it sorts gsprites in depth order as well and stores this depth data in the gsprite data structure. (Kajiya et al., column 13, lines 31-42).

According to the above description in Kajiya et al., in the system of Kajiya et al., the objects in the scene are sorted in Z-order and each non-interpenetrating object is preferably assigned to one gsprite, while interpenetrating objects are assigned to one gsprite. Therefore, each gsprite has its own depth information (a Z value) and the gsprites are sorted in Z-order for rendering on a basis of a unit of chunk. It should be noted that each gsprite does not have per-pixel Z values and the depth information is only provided on a per gsprite basis.

On the other hand, in Applicant's claim 19 the rendering data generated for each subspace has depth information on a pixel by pixel basis, and the rendering data is consolidated by

evaluating a distance in depth direction on a pixel by pixel basis. Since the objects are grouped depending on the rendering strategy, interpenetrating objects can be grouped into the separate groups in the system of claim 19. Therefore, the per-pixel depth information is provided for the image data generated for each subspace and the per-pixel depth information is used for consolidating the images between the subspaces. This technical feature is neither disclosed nor suggested in Kajiya et al. and the other cited documents. Therefore, the rejection of Applicant's amended independent Claim 19 should be withdrawn.

The differences between Applicant's amended independent Claim 19 and Kajiya et al. also apply to Applicant's new Claim 32. Specifically, in Applicant's new Claim 32 the independent image data generated for each subspace has per-pixel Z values indicating depth information on a pixel by pixel basis, and the final output image data is generated by performing Z-merge processing of the image data generated for each subspace according to the per-pixel Z values. Since the objects are grouped depending on the rendering strategy, interpenetrating objects can be grouped into the separate groups in the system of new Claim 32. Therefore, the per-pixel Z values are provided for the image data generated for each subspace and the per-pixel Z values are used for Z-merging the images between the subspaces. This technical feature is neither disclosed nor suggested in Kajiya et al. and the other cited documents. As such, Applicant's new Claim 32 is allowable over those references.

Claim Rejections under 35 U.S.C. § 103

Claims 9-14, 17, 18, 23 and 24 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Kajiya et al. in view of

Ma et al. Applicant respectfully traverses these rejections.

Applicant has amended independent Claims 17 and 18 in a manner similar to amended independent claim 1. As such, the rejections of independent Claims 17 and 18 should be withdrawn for at least the same reasons provided above for Claim 1. Furthermore, the rejections of dependent Claims 9-14 and 23-24 should also be withdrawn for at least these same reasons.

Claims 15 and 16 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Kajiya et al. in view of Ma et al. and further in view of Watts et al. Applicant respectfully traverses these rejections.

The rejections of dependent Claims 15 and 16 should be withdrawn for at least the same reasons provided above for Claim 1 due to their dependency thereon.

Additional Remarks for New Claims

New claims 25-29 and 32 and reasons for their patentability over Kajiya et al. were mentioned in the above remarks.

According to new Claim 30, the grouping unit groups the three-dimensional objects into groups in such a manner that the subspaces, each of which contains the three-dimensional objects belonging to the same group, overlap one another.

According to claim 30, since the objects are grouped according to the rendering strategy, the subspaces, each of which contains the three-dimensional objects belonging to the same group, may overlap one another. Since the subspaces are allowed to overlap one another, it gives flexibility in grouping the objects. In fact, any grouping of the objects becomes possible when the overlapping of the subspaces is allowed. Particularly, as claimed in new Claim 28, the intersecting three-dimensional

objects, to each of which a different rendering strategy is applied, can be grouped into the separate groups.

The system of Kajiya et al. will generally use an independent gsprite for each non-interpenetrating object in the scene. (Kajiya et al., column 5, lines 64-65). If processing resources allow, each non-interpenetrating object in the scene is assigned to an independent gsprite. Interpenetrating or self-occluding objects may be processed as a single gsprite. (Kajiya et al., column 12, lines 17-20). The system of Kajiya et al. does not allow the intersecting objects to be assigned to the separate gsprites, because the intersecting objects have to be assigned to the same image layer (gsprite) so that the intersecting objects can be z-sorted and then rendered within the same layer. This is a limitation in the system that adopts the tiling (chunk) technology.

For example, consider a scene where a ball goes through the leaves of a tree. The ball penetrates the leaves. The system of Kajiya et al. will handle the scene by assigning these interpenetrating objects, the ball and the leaves, to one gsprite. Embodiments of the present invention can handle the scene differently from Kajiya et al. by grouping the ball and the leaves into separate groups so as to apply one rendering strategy to the ball and another rendering strategy to the leaves. In this way, a rendering strategy suitable for a moving object, such as motion blur processing, can be applied to the ball, while another rendering strategy suitable for a less moving object is applied to the leaves.

The cited documents do not disclose nor suggest the significant technical features recited in new Claims 30-31.

According to new independent Claim 33, a grouping unit

groups input three-dimensional objects into groups. A rendering processing unit derives a subspace which contains the three-dimensional objects belonging to the same group to be an independent rendering unit and performs rendering processing individually on the subspace, and generates independent image data having per-pixel Z values indicating depth information on a pixel by pixel basis for each subspace. A consolidation unit generates final output image data to be displayed by performing Z-merge processing of the image data generated for each subspace according to the per-pixel Z values.

New independent Claim 33 is allowable over Kajiya et al. for reasons similar to those described above for amended independent Claim 19 and new Claim 32.

Fees Believed to be Due

When this application was filed a fee was paid for a total of 24 claims with 6 claims being independent claims. The above amendment has resulted in there now being a total of 32 claims with 7 claims being independent claims. Thus, fees are believed to be due for 8 extra total claims and 1 extra independent claim.

CONCLUSION

In view of the above, Applicant submits that the pending claims are in condition for allowance. Should there remain any outstanding issues that require adverse action, it is respectfully requested that the Examiner telephone Richard E. Wawrzyniak at (858)552-1311 so that such issues may be resolved as expeditiously as possible.

Respectfully submitted,

Date: 3/14/06

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Enclosure: Replacement Sheet for FIG. 21

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